2003 FAA National Software Conference
Field Loadable & User-Modifiable Software

Order 8110.49

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Order 8110.49

- **Approval of Field-Loadable Software (FLS)**
- **Approval of FLS by Finding Identicality through the Parts Manufacturer Approval (PMA) Process**
- **Approval of Airborne Systems and Equipment Containing User-Modifiable Software (UMS)**

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DO-178B References to FLS

- Field-Loadable Software (FLS) and Loading References:
  - System Design: Sections 2.0 and 2.5
  - SW Process: 6.4.3a., 7.2.1d., e.; 7.2.8, 8.3g.
  - SW Data: 11.1g., 11.2c.(3), 11.4b.(8), (9); 11.10g., 11.11, 11.15, 11.16, 11.20g.

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Definitions

Field-Loadable Software	Software that can be loaded without removal of the equipment from the aircraft installation.
User-Modifiable Software	Software intended for modification by the airplane operator without review by the certification authority, airframer, or equipment manufacturer.
Option-Selectable Software	Software that contains approved and validated components that may be activated by the user.

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Examples

- Field-Loadable Software
  - Engine Control Software
  - Flight Control Software
  - Boeing 777 Has Many Systems With FLS
- User-Modifiable Software
  - Non-Required, Airline-Specific Electronic Checklists
- Option-Selectable Software
  - Selection Of Sensors For An FMS

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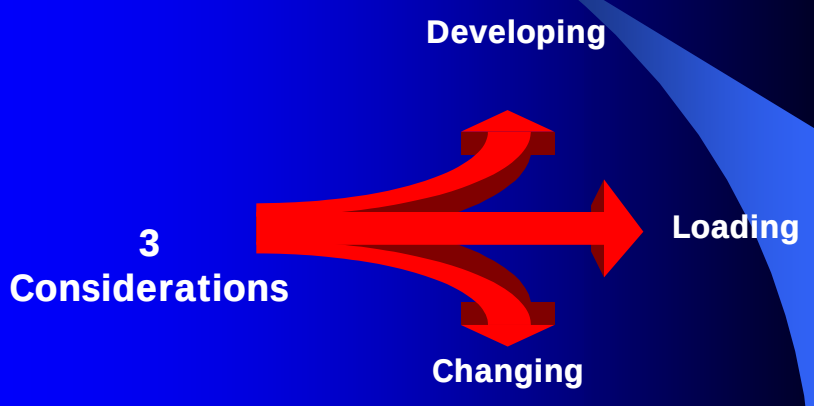
Approval of FLS



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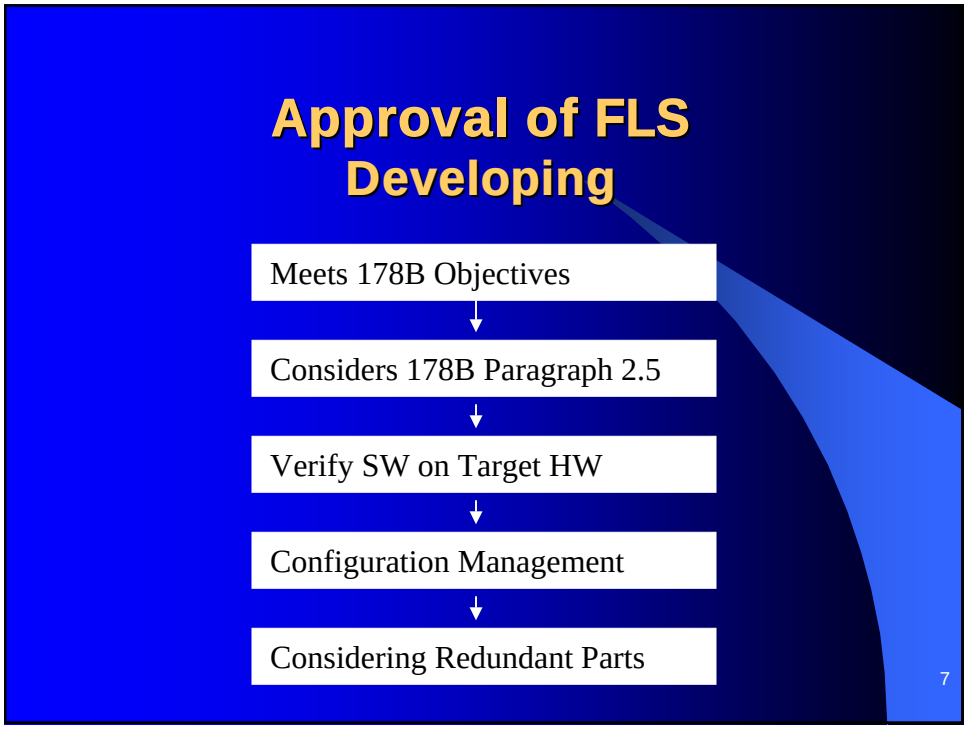
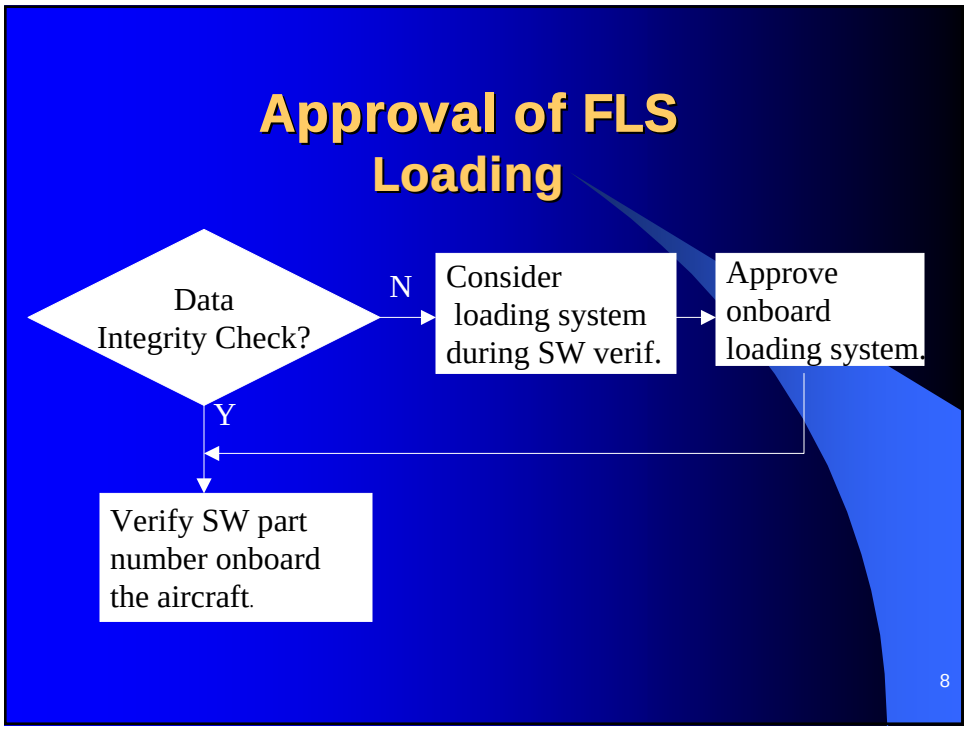

Approval of FLS
Developing
Meets 178B Objectives
Considers 178B Paragraph 2.5
Verify SW on Target HW
Configuration Management
Considering Redundant Parts
7


Approval of FLS
Loading
Data
Integrity Check?
N
Consider
loading system
during SW verif.
Approve
onboard
loading system.
Y
Verify SW part
number onboard
the aircraft.
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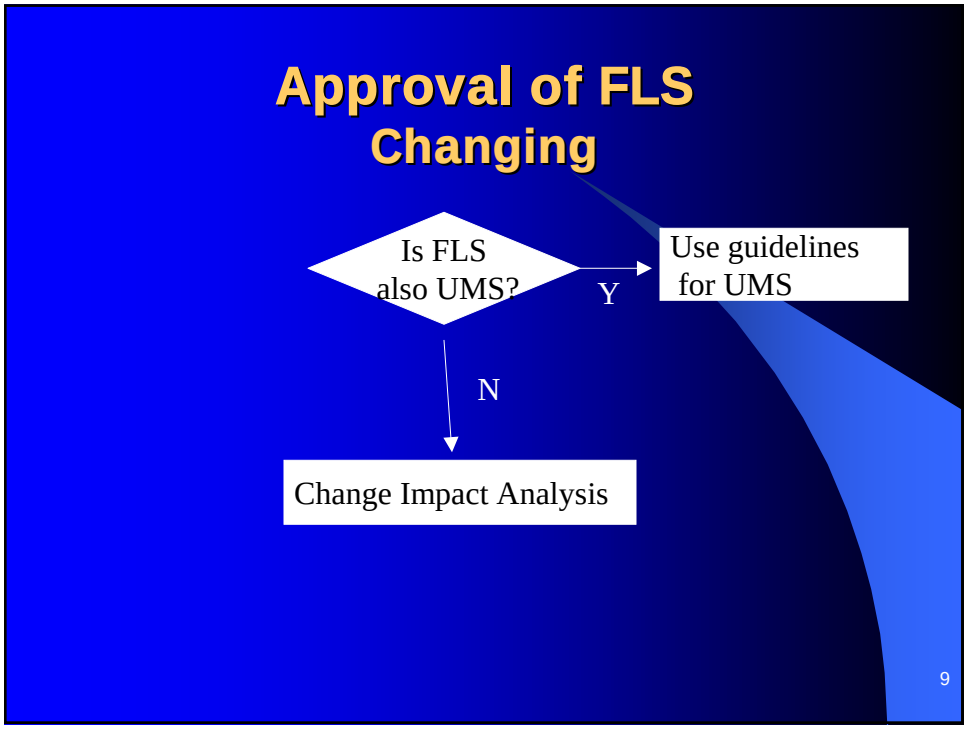
Approval of FLS
Changing
Is FLS also UMS?
Y
Use guidelines for UMS
N
Change Impact Analysis
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Installation of FLS
Documentation to Include the Following Items:
a) Aircraft and HW Applicability
b) Verification Procedures
c) Post Load Verification and/or Procedures
d) Actions for Unsuccessful Load
e) Reference to Approved Loading Procedures
f) Maintenance Record Entry Procedures
g) Reference to AFM, AFMS, or Ops Manual
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Maintenance & Part Marking of FLS

- Maintenance Procedure in Aircraft Maintenance Manual
- Procedure to Include Reading of SW Version
- Procedure to Include Part Number in Maintenance Records
- Changes Reflected in Appropriate Manual or Logbook

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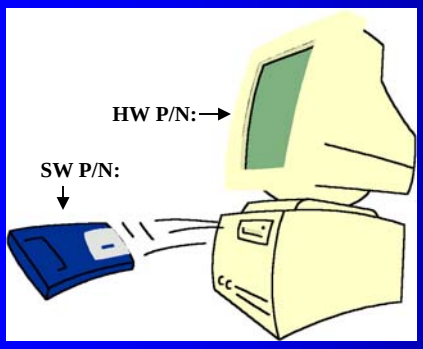
Maintenance & Part Marking of FLS



Procedure to Verify SW Load

Procedure to Verify Nameplate & SW Load

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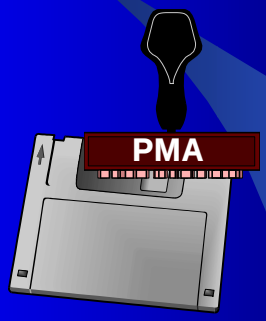
Parts Manufacturer Approval of Field-loadable Software



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Purpose

- Provides Guidelines for Approving FLS Through PMA
- Limited to Identicality With or Without a Licensing Agreement
- Does Not Cover Test and Computation

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Technical Information

- FLS Is Beneficial to Airlines and Applicants
- Order 8110.42, "PMA Procedures," Does Not Specifically Address Software
- CFRs 21.301, 303, and 305 Do Not Specifically Address Software
- Data Being Loaded Is Approved, Not Media

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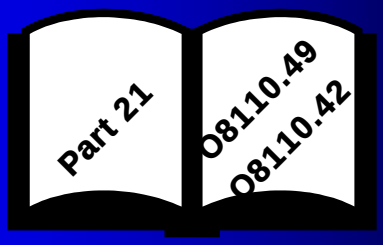
Procedures

- Follow Part 21 and O8110.42 in Conjunction With the Software-Specific Procedures in O8110.49



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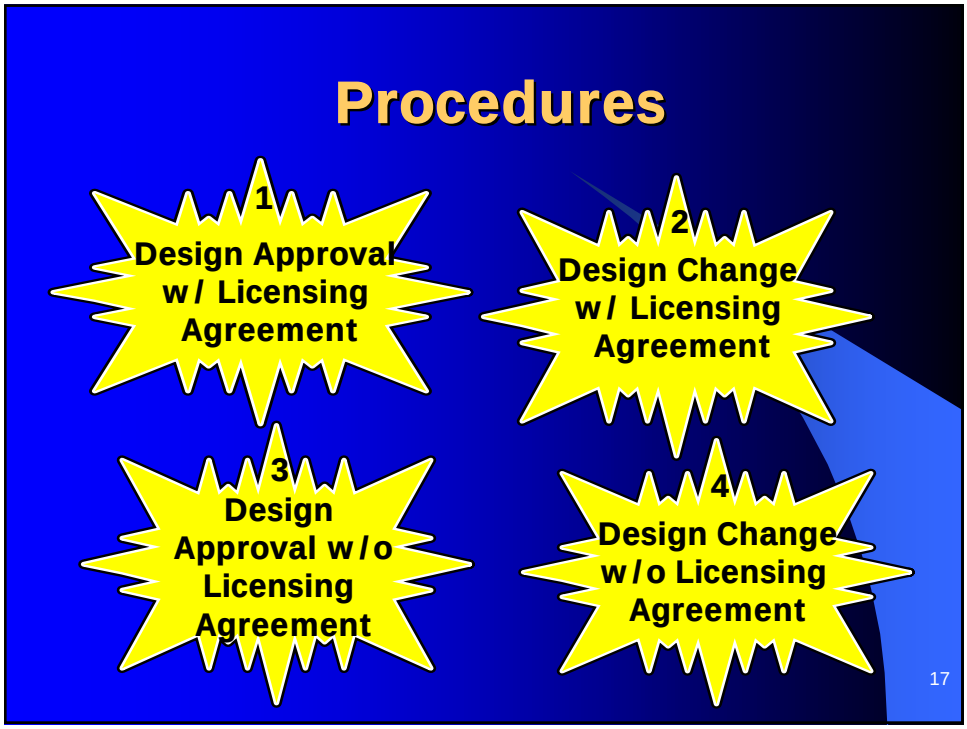

Design Approval Identicality With Licensing Agreement

- Reference O8110.42, 8(a)(3)(a)
- FLS Should Be Approved Through TC, STC, ATC
- FLS Should Be Installed Via Service Bulletin Or Similar Means
- Configuration Management Process Should Be In Place To Assure Software Part Number, Hardware Part Number, Aircraft Series, etc. Are Accurate

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Design Change Identicality With Licensing Agreement

- Reference O8110.42, 8(h)(5)
- Applicant Should Coordinate Change With TC, STC, ATC Holder
- Change Impact Analysis
- Determine Minor/Major Classification
  - Major change ⇒ O8110.42 8(h)(5)(a)
  - Minor change ⇒ O8110.42 8(h)(5)

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Design Approval Identicality W/o Licensing Agreement

- Order 8110.42, 8(a)(3)(b) - Parts Must Be Identical In "All Respects"
- FLS Should Be Identical To The Software On The TC, STC, ATC Approval
  - Bit-by-bit Comparison
  - Evidence of Identical Type Design Data - DO-178B Section 9.4

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Design Change Identicality w/o Licensing Agreement

- Change Considered Major
- Reference Order 8110.42, 8(h)(5)(a)

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Summary

- Chapter 5 - Approval of FLS
- Chapter 6 – Approval of FLS by Finding Identicality through PMA
- Reference DO-178B, Part 21, and Order 8110.42

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Approval of Airborne Systems and Equipment Containing User-modifiable Software

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Purpose

- To Provide Guidelines To ACO Engineers and DERs For Approval of Systems With User-Modifiable Software (UMS)
- To Encourage Working With Flight Standards Personnel:
  - Maintenance Inspectors, Avionics Inspectors, and Operations Inspectors

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DO-178B References to UMS

- User-Modifiable Software (UMS) References:
  - System Design: Sections 2.0 and 2.4a.-d.
  - SW Process: 5.2.3, 7.2.2b.
  - SW Data: 11.1g., 11.10g., 11.20g.

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Technical Information

Biggest Concerns:

- Corruption of Non-modifiable, Safety-related Software
- Change Control Problems in the Field
- Compelling but Invalid Information in the Cockpit

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Definitions

User-Modifiable Software	**Software intended for modification by the airplane operator without review by the certification authority, airframer, or equipment manufacturer.**
Option-Selectable Software	**Software that contains approved and validated components that may be activated by the user.**
Field-Loadable Software	**Software that can be loaded without removal of the equipment from the aircraft installation.**

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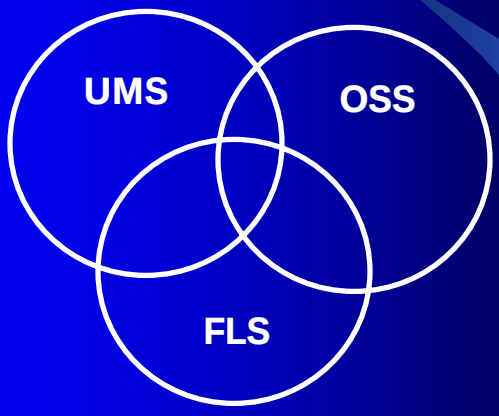
Definitions



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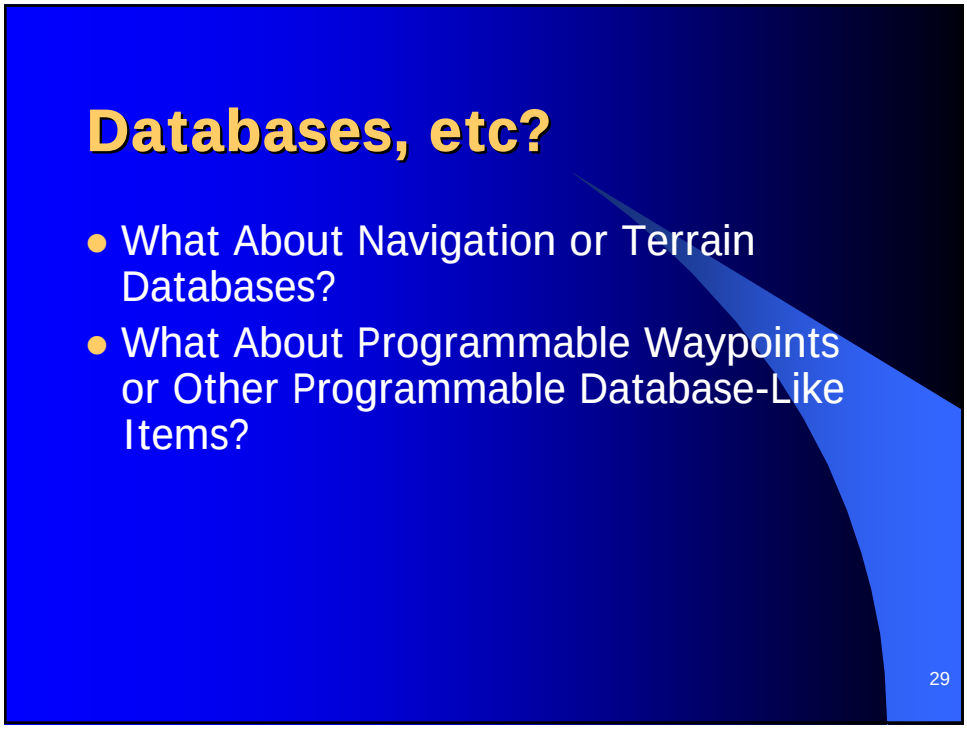
Databases, etc?
What About Navigation or Terrain Databases?
What About Programmable Waypoints or Other Programmable Database-Like Items?
29


Order Addresses UMS Only
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Earlier Version of DO-178 (Section 6)

- Earlier Versions of DO-178 Contain No Guidance for User-Modifiable Software
- Use DO-178B Guidance for The User-Modifiable Portions

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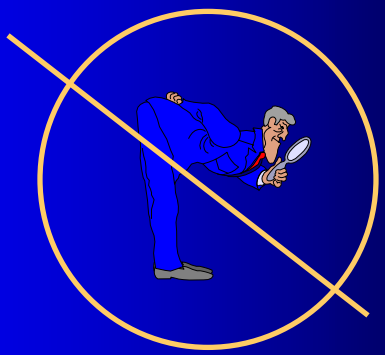
Safety Considerations

- **Once Certified as UMS There is No Certification Authority Oversight**



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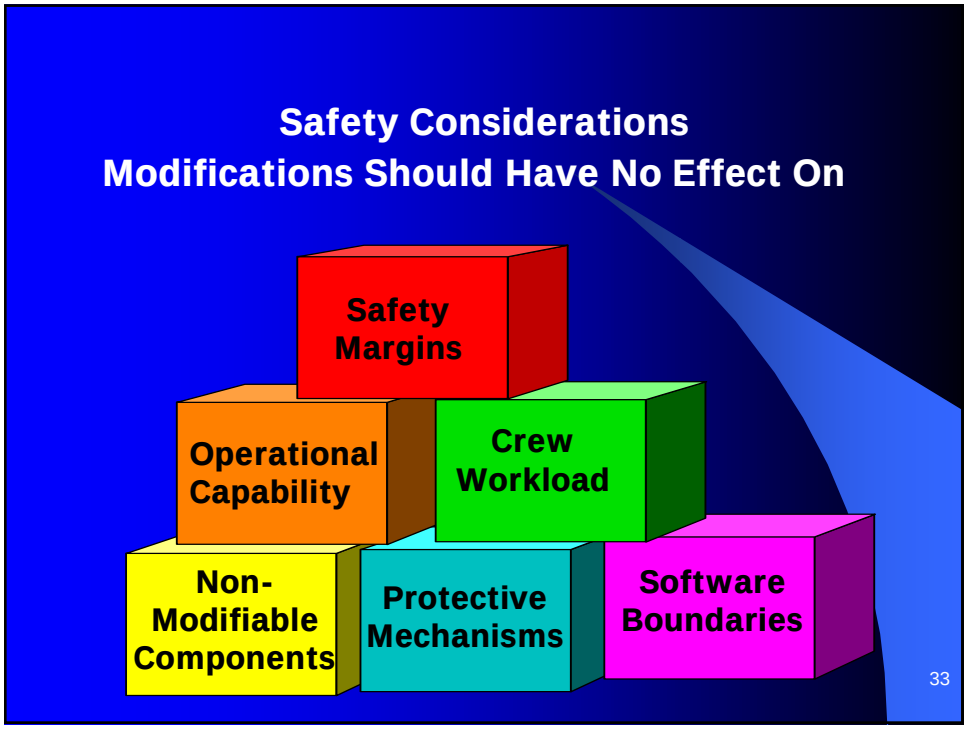
Safety Considerations
Modifications Should Have No Effect On
Safety Margins
Operational Capability
Crew Workload
Non-Modifiable Components
Protective Mechanisms
Software Boundaries
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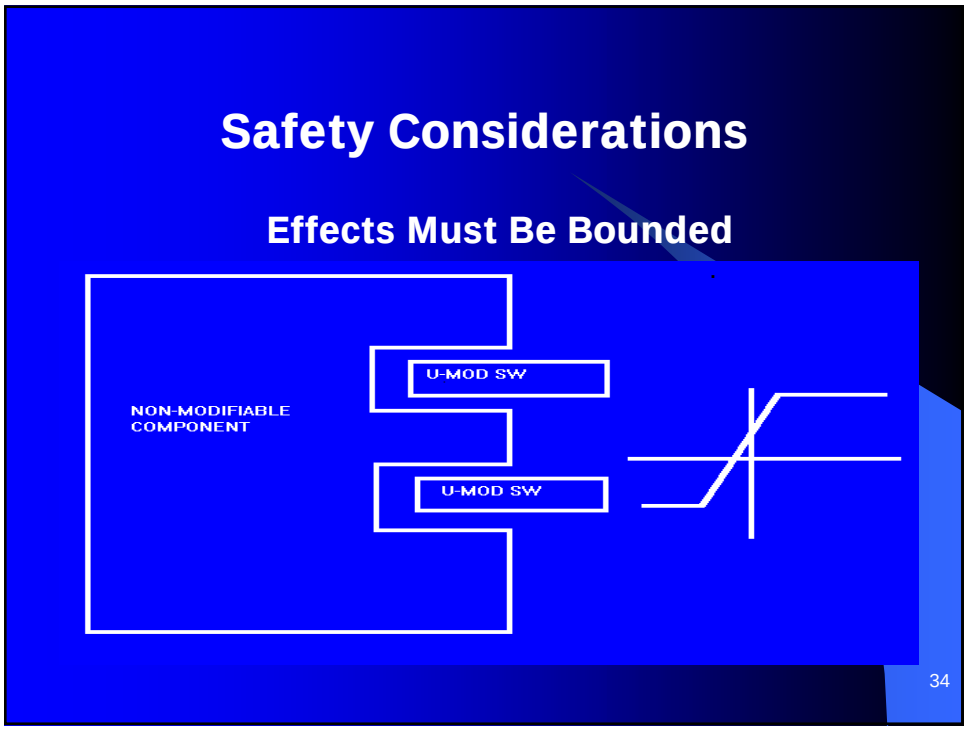
Safety Considerations
Effects Must Be Bounded
NON-MODIFIABLE COMPONENT
U-MOD SW
U-MOD SW
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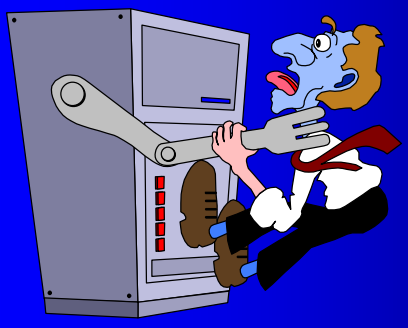
Identification of Displayed Data



- Obvious or Explicit Indication That the Data is Not Cert Authority Approved

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Performance Parameters

- **Modifications to Provide or Revise Performance Parameters Requires Certification Authority Review and Approval**
- **Examples of Parameters**
  - **Safety margins**
  - **Operational capabilities**
  - **Crew workload**

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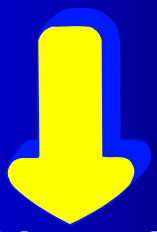
Performance Parameters

- Changing Data To Determine Aircraft Performance Parameters = Major Change



- User-Modifiable Designation Lost

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Protection

- UMS Components Shouldn't Affect Non-UMS Components
- Assure Protection Is Developed to at Least Same Level of Robustness Required of the Most Robust Non-UMS Component

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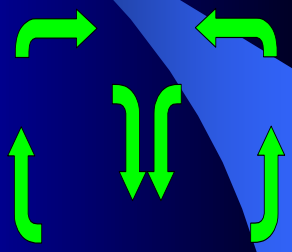
Protection

- Two Considerations
  - Operating In:
    - Protection in the design and operation
  - Changing Out:
    - Protection during modification



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Protection

- **Examples**
  - **Partitioning**
  - **Hardware Modes**
  - **Encoding**
  - **Tools**
    - **Modifications**
    - **Loading Protection**

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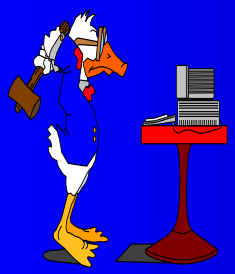
Protection



Protect Against Breaches

- Accidental Breach
  - Low Likelihood Under Reasonably Probable Circumstances
  - (Subjective statement of probability - not a xx.1309 definition)
- Intentional Breach
  - Low Likelihood Without Undue Effort

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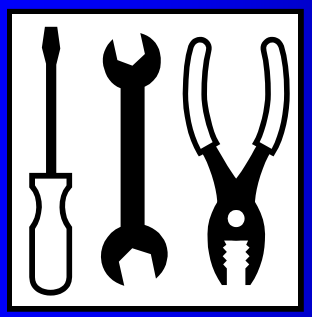
Tools



- **Used to Enforce Protection**
  - **Not DO-178B Qualified Tools?**
- **Demonstrated As the Only Means To Modify UMS Component**

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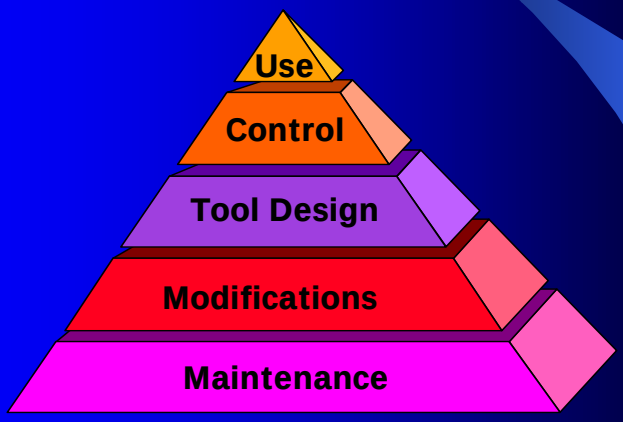
Tools

Requires Review and Approval Of:



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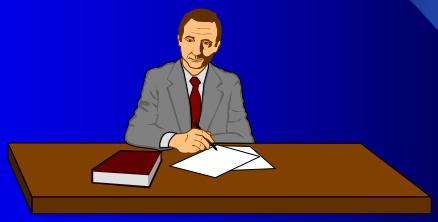
Tools

Design Approval of Tools



By ACO Engineer

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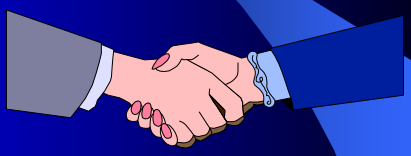
Tools

Maintenance Approval of Tools



Jointly By:

ACO Engineer
Operational Authority
Maintenance Authority

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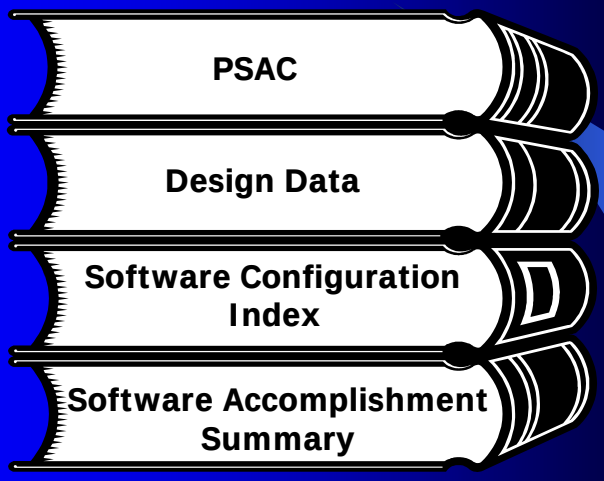
Data Requirements



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Other Considerations

- User Follows the Approved Procedures for Modifications to UMS
- User Responsible for Configuration Management, Quality Assurance, and Verification of the Software
- Changing Anything Besides UMS Can Result in Certificate Being Rescinded

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Summary

- Order 8110.49 Provides Guidelines For Approval of Systems & Equipment Containing UMS
- Provides Guidelines On:
  - Safety Considerations & Safety Parameters
  - Protection
  - Tools
  - Data Requirements
  - Working With FSDO Personnel

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